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MINI-REVIEW

Reparative surgery for degenerative mitral valve regurgitation

Jen-Ping Chang*

Division of Thoracic and Cardiovascular Surgery, Kaohsiung Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Kaohsiung, Taiwan

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Summary Reparative surgery for degenerative mitral valve regurgitation or insufficiency has been the subject of countless articles in the literature over the past five decades. During this period, a wealth of experience has contributed to greater understanding of mitral valve anatomy and pathophysiology. Excellent surgical techniques for the treatment of mitral regurgitation have been developed and are undergoing further refinement. With the efforts of the pioneers, standard surgical techniques, strategies, and guidelines have been well established. These achievements significantly prolong the life-expectancy of patients, provide excellent long-term durability of the repaired valve, and reduce the risk of endocarditis. Mitral valve repair for degenerative mitral regurgitation also contributes to reduced risk of thromboembolic events and the need for life-long anticoagulation after mitral valve replacement.

1. Introduction

Mitral valve repair is the best option for treatment of degenerative mitral regurgitation. This issue has been the subject of countless articles in the literature over the past five decades. Prior reports have documented several advantages of mitral valve repair compared with replacement, including: lower operative mortality[1,2]; better preservation of left ventricular function[3]; lower incidence of stroke and endocarditis[4,5]; a lower rate of reoperation and complications of anticoagulation therapy; and superior long-term survival.[6] In the United States, the Society of Thoracic Surgeons Adult Cardiac Surgery Database also documented the significantly lowered operative risk of mitral valve repair and the progressive adoption of this procedure from 51% to 69%.[7] With the efforts of the pioneers, standard surgical techniques, strategies, and

* Corresponding author. Division of Thoracic and Cardiovascular Surgery, Kaohsiung Chang Gung Memorial Hospital, Chang Gung University College of Medicine, 123 Tapei Road, Niaosung District, Kaohsiung City, Taiwan 833, ROC.
E-mail address: c9112772@adm.cgmh.org.tw.

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guidelines have now been well established. The purpose of this mini review is to widen surgeons' acknowledgment of these important historic achievements, to summarize the modern state-of-the-art procedures, and to provide future perspectives on mitral valve repair for degenerative etiology.

2. Historical aspects

2.1. Restrictive annuloplasty

Direct attempts at mitral valve repair utilizing the techniques of suture annuloplasty under cardiopulmonary bypass support were initially described by Lillehei et al in 1957.[8] With the exception of McGoon's technique of posterior leaflet plication,[9] the mode of mitral valve repair was later modified by other surgeons with various types of commissural suture technique.[10–12] However, by these palliative techniques, recurrence of mitral regurgitation or stenosis was not rare on account of leaflet or subvalvular apparatus dysfunction, persistent annular dilatation, and fibrosis of the plicated commissures.

2.2. Comprehensive remodeling concept

During the period from the 1970s to the 1980s, the concept of comprehensive reconstructive valvular surgery was introduced by Carpentier of Paris, the most widely recognized advocate of the annular remodeling concept, the so-called "French correction".[13–15] Thus, the gate was opened to the modern comprehensive and sophisticated mitral reparative concept.

3. Modern state-of-the-art procedures

3.1. The role of ring annuloplasty

Mitral valve repair surgery has progressed and evolved dramatically since the inception of remodeling ring annuloplasty.[13–16] The value of this particular method during concomitant reconstructive procedures has been firmly established. Mitral valve repair without an annuloplasty ring is an important factor influencing post-repair durability.[17] Currently, ring annuloplasty is an essential component of mitral valve repair, as annular remodeling restores the anatomic shape of the annulus and ensures long-term maintenance of valve repair results.[18]

The rigid and semi-rigid rings proposed by Carpentier and his colleagues have been the most popular devices for remodeling ring annuloplasty.[13–16] Meanwhile, Durán et al advocated a flexible ring concept for allowing a continuous change of the mitral annular conformation during the whole cardiac cycle.[19] Furthermore, Chang et al extended this concept and proposed a pliable polytetrafluoroethylene (PTFE) partial ring for reducing the posterior annulus, with favorable results.[20] However, the debate regarding the ring rigidity ceased when Chang et al from Seoul found no significant clinical difference in the rate of recurrence of significant mitral regurgitation between rigid and flexible rings in a long-term follow-up study.[21]

Recently, saddle-shaped annuloplasty rings have been used increasingly more often to conform the mitral annulus to a nonplanar shape and possibly to reduce leaflet stress. The preliminary results seem promising, although larger and longer cohort studies are necessary.[22]

3.2. Leaflet and chordal management

In a study of degenerative mitral valve repair, Gillinov et al reported the factors influencing repair durability: repair without an annuloplasty ring; repair without sliding annuloplasty; and the use of chordal shortening instead of chordal transposition or artificial chordal replacement.[17] Since the introduction of PTFE as a chordal substitute, this has become the popular technique used by many surgeons instead of conventional procedures for correcting prolapse of the mitral leaflet, such as cusp resection, chordal shortening, and chordal transposition. This "respect but no resect" principle has changed the reparative technique for degenerative mitral regurgitation drastically and in most instances of degenerative mitral regurgitation repair, the conventional complex leaflet and subvalvular apparatus manipulation techniques have been aborted.[23,24] The optimal length of artificial chordae has been obtained by several methods, but direct measurement of the nonprolapsed corresponding chordal height or measurement of distance of the papillary muscle tip to the corresponding annulus is recommended. In addition, the PTFE sutures are slippery and difficult to tie down at the intended length. Numerous methods have been described to ensure the correct length of the artificial chordae, however, most of these techniques are complex, requiring custom-made special devices, and time consuming.[25] Therefore, further refinement of this valuable technique is needed.

3.3. Edge-to-edge repair

The edge-to-edge (E2E) mitral valve repair was advocated in the late 1990s by Alfieri et al.[26] This technique was initially described as a rescue method for difficult or failed mitral valve repair with the standard technique. However, later data reported by the same research group confirmed overall suboptimal results of the E2E technique when annuloplasty is not added to the repair.[27] Currently, this technique has been preserved as an alternative option for prevention of the systolic anterior motion of the mitral anterior leaflet in repairing the severe form of myxomatous degenerative mitral regurgitation (Barlow's valve).

4. Future perspectives

4.1. Robotic minimally invasive valvular surgery

Robotic surgery was made feasible following the integration and improvements of telemanipulation, three-dimensional vision, the computer-enhanced EndoWrist, and a tremor-filtering system. Chitwood et al reported their experience in 300 cases of mitral repair with excellent results comparable with those of the conventional open technique.[28]

However, few surgeons have adopted this state-of-the-art technology in their daily practice because the method is expensive, highly sophisticated, has a steep learning curve, and demands a meticulous combination of modern technologies.

4.2. Percutaneous catheter-based approach

Two-year follow-up data from the EVEREST II trial show that although a catheter-based mitral valve repair procedure using the MitraClip system was less effective in reducing mitral regurgitation than conventional surgery, similar improvements in clinical outcomes were observed with fewer short-term adverse events.[29] The major drawbacks of this catheter-based E2E technique are doubtful long-term durability and potential creation of a stenotic mitral valve.

Data from the EVOLUTION phase 1 study to assess the safety and efficacy of the percutaneous coronary sinus device (MONARC device) show limited feasibility and efficacy. It is noteworthy that coronary artery compression may occur in patients whose greater cardiac vein passes over a coronary artery, necessitating some future strategies to avoid this serious complication.[30]

The development of robotic surgery and the catheter-based approaches for repairing mitral regurgitation are important and inevitable trends. At present, however, considering the current excellent long-term survival and results achieved from the conventional open reparative techniques for degenerative mitral regurgitation, a very cautious attitude towards application and evaluation of such new technologies is mandatory.

5. Summary

Mitral valve repair for degenerative mitral regurgitation is a well-established therapeutic option and has been practiced worldwide. Unfortunately, the reported number of cases using this procedure in Taiwan remains smaller than that reported in North America and European countries.[7] Although mitral valve repair is technically demanding, with the accumulation of sufficient experience, success should be achieved with consistency. We, the cardiac surgeons practicing in the current era, should consider every patient with degenerative mitral regurgitation, make all efforts to find reparable cases, and attempt repair in all suitable cases.

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